CHAPTER II
A SCRAP OVERVIEW

A. GENERAL

Thus far the term "scrap" has been used in a general sense. In the scrap recycling industry, the word "scrap" usually applies only to ferrous metal materials (iron or steel) which have no value except for their basic material content. "Metals" is the term the scrap recycling industry uses to describe nonferrous scrap, such as brass, copper, stainless steels, high temperature alloys, lead, zinc, aluminum, magnesium, manganese, cobalt, chromium, tin, nickel, cadmium, tungsten, titanium, mercury, and the precious metals. Other scrap, such as textiles, paper, plastics, chemicals, used or contaminated petroleum products, used synthetic lubricants, used solvents, rubber, leather, wood and food residue, are referred to as nonmetallic scrap. In DoD, the term "waste" means used or unused property, residues, by-products, sludges, and other materials which have no known utility and, therefore, must be discarded.

B. FERROUS SCRAP

1. Although the terms "iron" and "steel" are frequently used interchangeably, they are not the same. Both iron and steel belong to the ferrous family, and their basic content is the element iron, but iron and steel are quite different materials.

2. Iron has a rather high carbon content; and it is cast into molds to produce such items as automobile motor blocks. It tends to have a granular structure, like an apple.

3. Steel is also iron but has been refined to eliminate most of the carbon. Steel can be either carbon steel or alloy steel. Carbon steel, the most common type of steel, varies in carbon content, the higher the carbon content, the harder the steel. Alloy steels are iron based but contain varying amounts of other elements (such as chromium, nickel, manganese, silicon, vanadium or molybdenum) which are added to provide heat, wear and/or corrosion resistance. Stainless steel, for example, is an alloy steel which contains various percentages of nickel and chromium. Steel is generally fibrous, something like celery. It may be produced in the form of steel castings or rolled into such products as bars, structural shapes, plates, sheets, pipe and rails.

4. Use of iron and steel scrap, which has a much lower carbon content than raw pig iron produced from iron ore, shortens the melting process in all types of furnaces and thus significantly reduces energy requirements and other costs involved in the manufacture of iron and steel products. Moreover, iron or steel manufactured from recycled ferrous scrap usually results in a better end product than that produced solely from raw pig iron, no matter how old or rusted the scrap may be.

5. Four types of furnaces—open-hearth, electric, basic oxygen and blast—constitute the principal producing units of today's steel industry (see Fig. II-l).

a. The blast furnace is primarily used to reduce iron ore into pig iron or "hot metal." When iron from the blast furnace is cast and chilled into molds, it is called pig iron. When it is tapped into a ladle and conveyed directly to an open-hearth furnace for refining into steel, it is called hot metal.

b. Ferrous materials are loaded into open-hearth furnaces either as a "cold" charge (usually iron and steel scrap) and/or a "hot metal" charge of molten iron. About 41-43 percent of the total ferrous input to open-hearth furnaces is scrap. Limestone is used for the bottom layer of the furnace to draw off impurities. Then iron ore, scrap and hot metal are added, in that order, on top of the limestone. Before the melting process is completed, more scrap and hot metal are usually added. The tremendous heat that passes over this molten bath vaporizes impurities *or* attracts them to the top as slag. After 8 or 9 hours, the slag on top is tapped off and the steel is poured into a ladle for casting into ingots.

FERROUS SCRAP CYCLE

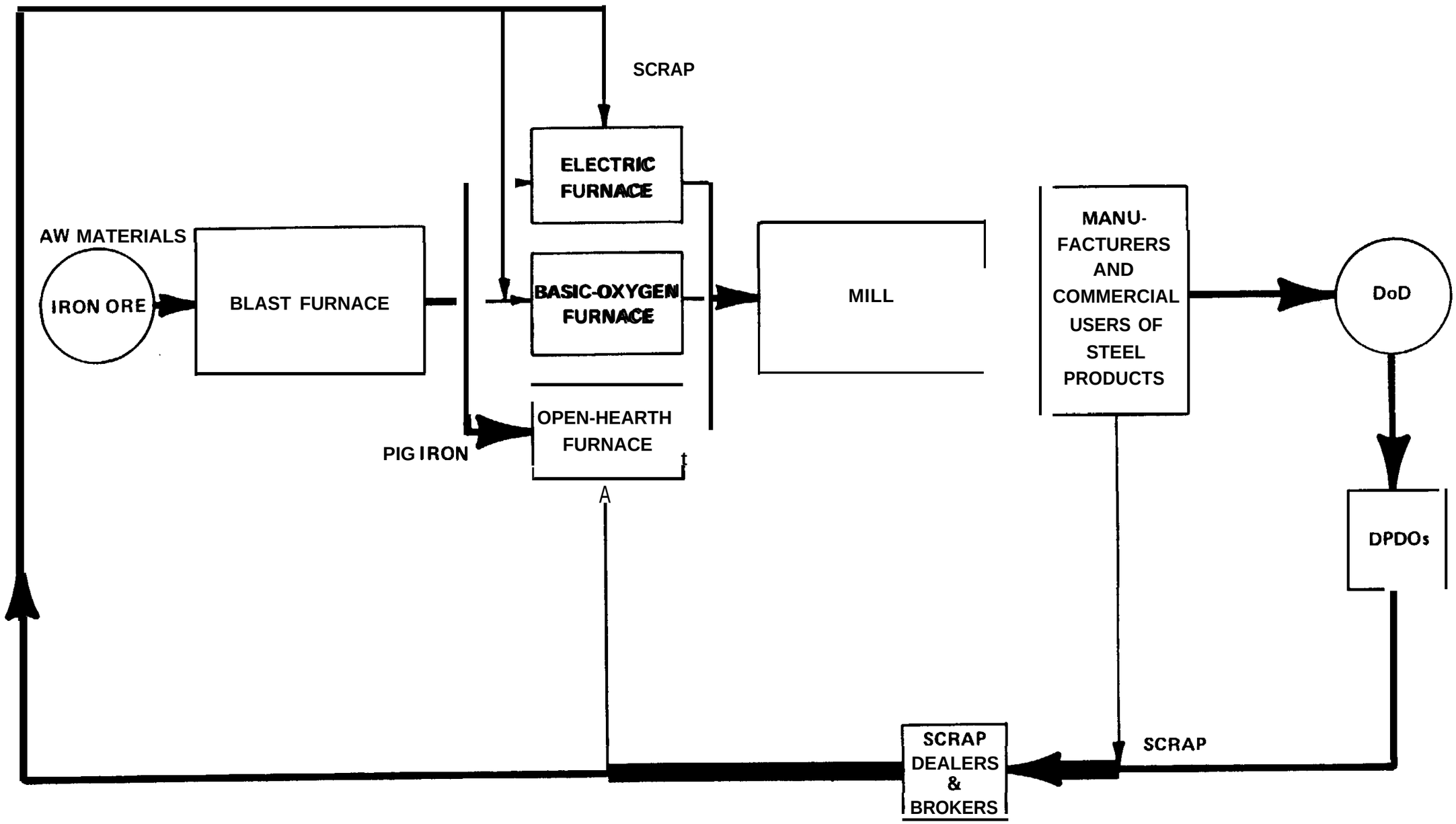

FIGURE II-1
II-2

c. Basic oxygen furnaces that employ the Linz-Donawitz (L-D) process (in which the bath of molten metal is lanced with a jet of oxygen) use only about 25-30 percent scrap. Because of their relatively low cost of construction and operation (as compared to open-hearth furnaces) and the fact that they require less than 1 hour per heat, L-D capacity throughout the world is increasing.

d. Electric furnaces which use electric energy for heat are operated as a nonoxidizing melting furnace that can accept up to a 100 percent charge of scrap under certain conditions. (Normally, however, a charge of about 96 percent scrap and four percent pig iron is used.) Because of their low energy consumption and the low initial capital outlay required, these furnaces are also assuming an increased share of world steel production.

6. Segregation of most ferrous scrap (iron and carbon steel) is based more on the physical dimensions of the scrap rather than on the chemical composition of the scrap. However, in the case of alloy steel scrap (see chapter V), segregation should be based primarily on its alloying constituents.

C. NONFERROUS SCRAP

1. The term "nonferrous scrap" applies to all metallic scrap except that which consists primarily of iron and steel. Because of the fact that we must depend on foreign sources for supply of a large portion of our requirements for nonferrous metals, and because of the high market price of nonferrous scrap per unit of weight, the handling of nonferrous scrap deserves top priority attention by all concerned.

2. Nonferrous metals have unique individual properties and characteristics, such as high corrosion resistance, lightness with strength, high reflectability, electrical and thermal conductivity, excellent bearing qualities, and spark resistance. The strength, hardness, and elasticity of nonferrous metals varies with the type of alloying constituents and the exact percentage of each used in the alloying process. A variation of only a few tenths of one percent in one element of the alloy may significantly change the physical characteristics of the alloy.

3. Most of the difficulty that smelters encounter when using nonferrous scrap is a result of contamination caused by improper segregation and classification. When nonferrous scrap is kept clean, properly classified, and free from contamination with other materials, it can be used to produce an ingot that compares favorably for many purposes with a virgin ingot. Conversely, any degree of contamination will seriously degrade the value of otherwise good scrap for use in producing a fully acceptable alloy. Specifications for all nonferrous alloys are very definite and strict. The mixture of any quantity of off-grade scrap can contaminate a pile of otherwise good quality scrap. When this occurs in the remelting process, the entire melt must be upgraded by adding more precisely identified metals (e.g., copper, tin) to bring the alloy up to standard specifications.

D. NONMETALLIC SCRAP

The recovery of this type of scrap is a vitally important element of the DoD Scrap Recycling Program since it is continuously generated in large quantities at all DoD installations. Although it may not appear to be as glamorous to handle as other types of scrap, it provides much greater benefits (in terms of sales proceeds) because of its higher value per ton than does ferrous scrap. Those segments of the scrap recycling industry concerned with processing nonmetallic scrap are, in many ways, more complex and varied than those concerned with metallic scrap.

E. SCRAP RECYCLING CONSERVES NATURAL RESOURCES

1. As indicated at the beginning of chapter I, the most important reason for recycling DoD scrap generations is to conserve our rapidly dwindling natural resources, including those required for the production of energy. In addition, the DoD Scrap Recycling Program can contribute significantly to reducing the net cost of other DoD programs by reducing outlays otherwise required to effect environmentally safe abandonment or destruction of hazardous scrap through costly service contracts. This effort returns millions of dollars generated from scrap sales to the U.S. Treasury and DoD activities, and utilizes precious metals recovered from scrap for authorized internal purposes or as Government Furnished Material (GFM) to DoD contractors.

2. A ton of recycled ferrous scrap can replace over one and one fourth tons of iron ore in the production of steel; and recycled nonferrous scrap currently fulfills 25 percent of the aluminum, 50 percent of the copper, 50 percent of lead, and 14 percent of the zinc requirements of the United States. Our metallic scrap resources can therefore truly be considered as "mines above ground." Similarly, paper scrap can be considered as a "secondary forest" since each ton of waste paper replaces over eight-tenths of a ton of wood pulp, and each ton of wood pulp saved by recycling paper scrap is equivalent to an annual growth of pulp-

wood timber on 1.6 acres of timberland. Thus, the total benefits from paper recycling in the United States currently equates to saving 200 million trees annually or 20 percent of the total raw materials used in paper production. If we could increase this rate to 50 percent, each year we could conserve a forest equal in total area to the states of New Jersey, New York, Pennsylvania and Maryland. Recycling of other nonmetallic scrap, such as textiles, rubber, oil, and chemicals, has a comparable potential for making a significant contribution to our national economy.

3. In the area of energy conservation, recycling of ferrous scrap, in lieu of refining iron ore, generates a 60 percent energy savings. For example, the energy saved in producing 1000 tons of steel from ferrous scrap is equivalent to that contained in 140,000 gallons of gasoline. Energy savings resulting from the recycling of nonferrous scrap, in lieu of refining nonferrous ores, range from 60 percent for lead and zinc to 80 percent for copper and 96 percent for aluminum; and recycling of paper and rubber scrap is 60 to 70 percent more energy efficient than is the production of paper and rubber from raw materials. Overall, the National Association of Recycling Industries estimates that at least two percent of total United States energy demand could be met from energy saved simply by recycling available steel, aluminum and paper scrap.

4. Despite the substantial benefits of scrap recycling, as outlined above, in reality the DoD Scrap Recycling Program to date has only addressed the "tip of the iceberg." It is therefore of vital importance that DoD—as one of the world's major consumers of scarce natural resources—takes the lead in enhancing the efficiency of its recovery and recycling of scrap.